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1996 Platte River Basin Ecosystem Symposium Proceedings

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1996 Platte River Basin Ecosystem Symposium

February 27, 1996: Kearney, Nebraska

Fisheries of the Platte River Basin

A Survey of the Warmwater Stream Fishes of the Platte River Drainage in Wyoming
Timothy M. Patton, Graduate Research Asst, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, WY 82071-3166 (completed research) | Abstract

Fish Species Composition in the Central Platte River, Nebraska
Don Conklin Jr., Chadwick Ecological Consultants, Inc., Littleton, Colorado (progress report) | Abstract

Distribution, Habitat Use and Food Habits of Sturgeon in the Lower Platte River, Nebraska
Robin Hofpar, Graduate Research Asst, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

An Ichthyological Survey of the North and South Platte Rivers in Western Nebraska
John D. Lynch and **Brian R. Roh**, University of Nebraska-Lincoln, School of Biological Sciences, Lincoln, Nebraska (completed research) | Abstract

Landscape and Water Management

Designing Hydroperiods for Riparian Wetlands in Wyoming and the Implications for River Management
Todd Yeager, Graduate Research Asst, Rangeland Ecology and Watershed Management, University of Wyoming (progress report) | Abstract

Water Quality in a Wet Meadow, Platte River Valley, Central Nebraska
Patrick J. Emmons, Hydrologists, U.S. Geological Survey, Lawrence, Kansas (progress report) | Abstract

A Plant Study and Comparison of Upland Cemeteries to Rangelands in Buffalo County, Nebraska
Troy Walz, Graduate Research Assistant, Biology, University of Nebraska at Kearney (completed research) | Abstract

Irrigation Water Conservation Practices for the Central Platte Valley, Nebraska
Dean E. Eisenhauer, Professor of Biological Systems Engineering, Univ. of Nebraska-Lincoln (completed research) | Abstract

Water Quality

Nutrient Patterns, Mainstem South Platte River, Denver to Julesburg, Colorado: Seasonal and Temporal Variations, a Longterm Tom Sawyer Monitoring Program
John Wooding, Colorado Division of Wildlife, Denver, Colorado (completed research) | Abstract

Restoration of Two Platte River Basin Sandpit Lakes: Phosphorus Reduction Using Aluminum Sulfate
John C. Holz, Research Project Manager, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

Chronic Effects of Baseflow Levels of Atrazine on Platte River Algae
Karen J. Nelson, Graduate Research Asst, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

Middle Platte Econonic Assessment

The Platte River Watershed Protection Program: The Middle Platte Companion Economic Assessment
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Poster Session

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Mark M. Peyton, Senior District Biologist, Central Nebraska Public Power & Irrigation District, Gothenburg, Nebraska | Abstract

Alternative Uses for Marginal Cropland in the Platte Valley
Kent Pfeiffer, Research Management Associate, The Nature Conservancy, Aurora, Nebraska | Abstract

Impact of Selected Herbicides and Metabolites in the Platte and Elkhorn Rivers on Collector Well Water, Nebraska
Ingrid Verstragten, Hydrologist, U.S. Geological Survey, Lincoln, Nebraska | Abstract

Landscape Ecology

Landscape Ecology: A Primer and Overview of Application to the Central Platte River, Nebraska,
Paul Currier, Director, Platte River Whooping Crane Mantenance Trust, Inc (progress report) | Abstract

Use of GPS/GIS for Accuracy Assessment of Remotely Sensed Imagery
David T. Smith, Graduate Research Asst, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

Factors Influencing Red-Eyed Vireo Habitat Selection in Forest Fragments Along the Central Platte River, Nebraska
Christopher J. Colt, Graduate Research Asst, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

The Effect of Landscape Fragmentation on the distribution of Wet Meadow Grassland Birds
Chris Helzer, Graduate Research Asst, Forestry, Fisheries & Wildlife, Univ. of Nebraska-Lincoln (progress report) | Abstract

Instructions

Citations include whether the research was complete, or in progress, at the time of presentation.

A SURVEY OF THE WARMWATER STREAM FISHES OF THE PLATTE RIVER DRAINAGE IN WYOMING

Timothy M. Patton and Wayne A. Hubert, Wyoming Cooperative Fish and Wildlife Research Unit, National Biological Survey Laramie, Wyoming
Charley A. Wheeler and Frank J. Rahel, University of Wyoming, Department of Zoology and Physiology, Laramie, Wyoming

Abstract

We surveyed the warmwater stream fishes of the Missouri River drainage in Wyoming. In this paper, we present findings from the North and South Platte River drainages, which comprise 24% of the surface area of Wyoming. We collected fish from 77 locations in 32 rivers and streams during 1993 and 1995, and captured 30 warmwater species representing eight families. When compared to a similar survey that was conducted during the early 1960s, nine species exhibited reductions in distributions in the Platte River drainage in Wyoming. One species, the lake chub Couesius plumbeus, may have been extirpated from this drainage. Orangethroat darters, which were thought to have been extirpated from the state, were collected in Lodgepole Creek. Brook sticklebacks, which had not been collected previously in Wyoming streams, were collected in a tributary to the South Platte River. Of the 33 species collected during the 1960s and 1990s, over half (17) appear to have experienced distributional changes.

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Introduction

A statewide inventory of the endemic fishes of Wyoming was conducted in the 1930s by James Simon, and again in the early 1960s by George Baxter (Simon 1946, Baxter and Simon 1970). The data collected in those surveys provided much of what is known regarding the distribution of the warmwater, nongame fishes in Wyoming. However, numerous activities have taken place over the past few decades which have likely affected native riverine fishes. Among these are water development projects, expanded agricultural activities, non-native species introductions, and fisheries management activities. The extent to which native riverine fish communities have been altered is largely speculative.

In an effort to determine the current distributions of fishes in Wyoming, and to describe trends in distributions of these fishes, we surveyed streams of the Missouri River drainage during 1993-1995. We compared our data to that from the survey conducted during the 1960s. The Missouri River drainage in Wyoming includes all of Wyoming east of the Continental Divide, and represents 74% of the surface area of the state. Because we were interested primarily in distributions of warmwater, nongame fishes, we focused the survey on non-salmonid fishes in warmwater rivers and streams at <2,200 m in elevation. Major river systems in the Missouri River drainage in Wyoming include the Big Horn, Tongue, Powder, Little Missouri, Belle Fourche, Cheyenne, Niobrara, North Platte, and South Platte. In this paper, we present our findings from the Platte River basin, which includes the North and South Platte River drainages.

Study Area

The Platte River basin in Wyoming includes approximately the southeastern quarter of Wyoming, representing 24% of the surface area of the state (Figure 1). Elevations in the North Platte River drainage in Wyoming range from 1,230 m where The North Platte River flows into Nebraska to 3,660 m in the Snowy Range Mountains. The main stem of the North Platte River originates in the mountains of northern Colorado and flows through Wyoming into Nebraska. With the exception of the Laramie River and a few smaller streams, most of the tributaries to the North Platte River originate in one of two mountain ranges, the Snowy and Laramie ranges. The South Platte drainage in Wyoming consists of a few headwater streams that originate in extreme southeastern Wyoming.

Mountain streams in both drainages are generally small (1st - 3rd order) and are characterized by high gradients, cobble and boulder substrates, and riparian areas dominated by conifers and willows. Fish communities are dominated by introduced salmonids. As streams flow onto the plains, they typically become characterized by low gradients, meandering or braided channels, silt, sand, and gravel substrates, and riparian areas dominated by cottonwoods, willows, shrubs, and grasses. Fish communities become dominated by native and introduced cyprinids and catostomids.

Methods

We selected perennial rivers and streams for sampling that ranged widely in size and geographic distribution within each of the two drainages. An effort was made to sample a number of locations within each stream proportional to the size of the stream. Thus, several locations were sampled on large streams, and one or few locations were sampled on small streams. We included in our survey those locations that were sampled during the survey conducted during the early 1960s where sufficient information (i.e., location descriptions), access, and discharge levels were available. Specific sampling locations within a stream were selected based upon representativeness (from visual observation) and accessibility. Because accessibility was used as a criterion for selection of locations, samples were taken upstream, from areas which may have been influenced by bridges, road crossings, or other obvious anthropogenic impacts whenever possible.

Fish sampling was conducted using electrofishing gear and seines. Electrofishing gear included a Smith-Root model 15-B backpack shocker and a Coffelt model VVP-2C bank unit. Both units were powered by gasoline powered AC generators. The backpack unit was used in small streams, while the bank unit was used in larger streams and rivers. Electrofishing was conducted using pulsed DC. Output at each location was adjusted until fish were sufficiently affected to enable capture with a dipnet Seining was conducted using a 4.6 x 1.2 m bag seine with a 4.8 mm mesh.

At each location, a single electrofishing pass was made over a 200-m reach. All affected fish were retrieved and placed in a live car. Two to five seine hauls were made at each location outside of the electrofishing reach and all captured fish were placed in a separate live car. An effort was made to seine all habitat types that were present (e.g. pools, riffles, backwaters, side channels). All fish were identified in the field and representatives of each species were preserved in 10% formalin. All other fish were released. Verification of identifications was conducted in the laboratory using preserved specimens.

Data on presence and absence of fish at specific locations were used to determine the current distribution of each species. The UTM coordinates were obtained for each location using US Geological Survey topographic maps (scale=1:24,000). We constructed a map of the sampled streams and UTM coordinates of each location using geographic information system technology.

We compared our data to that of the survey conducted by George Baxter during the early 1960s (Department of Zoology and Physiology Ichthyology Museum records, University of Wyoming, Laramie). Presence and absence data at each location and within each stream were used for comparisons. We constructed a table displaying the percentage of sites and streams from which each species was collected during respective surveys.

Results and Discussion

We collected fish from 72 locations in 31 rivers and streams during 1993 (Table 1, Table 3, Figure 2). During 1995 we collected fish from five locations on the main stem of the North Platte River. Thirty warmwater species representing eight families were collected from the North and South Platte River drainages (Table 2). The 1960s survey included 43 locations in 21 rivers and streams, and resulted in the capture of twenty-seven species representing six families (Table 3).

Sampling during the 1960s was conducted primarily using seines, while our data were collected using seines and electrofishing gear. This difference in gear efficiencies confounds comparisons. It is difficult to distinguish changes in species distributions due to the greater sampling efficiencies in the 1990s, particularly when attempting to determine expansions of species. For example, if a species was captured in more sites during the current survey than during the previous survey, it is difficult to determine if the difference represents an expansion of the species or an artifact of greater gear efficiency. We are currently developing techniques to account for differences in our gear efficiencies, thereby making inferences towards species experiencing distributional expansions more meaningful (Patton et al. in preparation).

Though problems exist when attempting to describe distributional expansions using the type of data available to us, inferences can be made with respect to decreasing distributions. If a species was captured in fewer sites and streams despite greater gear efficiency, this strongly suggests that the distribution of that species has experienced reduction. We identified six species that appear to be decreasing in distribution in the Platte basin in Wyoming: brassy minnow, common shiner, hornyhead chub, Iowa darter, plains topminnow, and suckermouth minnow (Table 3). These species were captured in appreciably lower percentages of sites and streams during the 1990s than during the 1960s. Our data indicate that the hornyhead chub and suckermouth minnow are now each restricted to a single stream.

We did not capture three species that were captured during the 1960s: flathead chubs, lake chubs, and river carpsuckers (Table 3). However, Wyoming Game and Fish Department personal have stated that they have captured flathead chubs in recent years from the mainstem of the North Platte River near Casper, Wyoming, and that river carpsuckers may be present in reservoirs and the mainstem along lower reaches of the North Platte River in Wyoming (William Wichers, Wyoming Game and Fish Department, Casper, personal communication). That we did not capture these species from rivers and streams despite relatively intensive sampling efforts suggests that these species have declined since the 1960s. Our data suggest that the lake chub has been extirpated from the Platte River drainage in Wyoming.

We captured five species that were not captured in any rivers or streams during the previous survey: emerald shiners, mosquitofish, smallmouth bass, brook stickleback, and orangethroat darters (Table 3). The first three species have been introduced into Wyoming. Emerald shiners were introduced into many of the reservoirs on the North Platte River as a forage species for sport fishes. Mosquitofish were introduced into lakes and irrigation ditches in southeastern Wyoming for mosquito control. Smallmouth bass have been introduced into various waters to provide sport fisheries (Baxter and Simon 1970, Stone and Baxter 1995). We collected brook sticklebacks from Lone Tree Creek, a tributary to the South Platte River near the Wyoming-Colorado border in 1993. This species had formerly been collected in small impoundments in the Lone Tree Creek drainage by Wyoming Game and Fish Department personnel (Donald Miller, Wyoming Game and Fish Department, Laramie, personal communication), and may have been accidentally introduced along with shipments of bait minnows. Alternatively, Thomas Nessler (Colorado Division of Wildlife, Fort Collins, personal communication) has suggested that brook sticklebacks may be native to the South Platte River drainage in Colorado. Consequently, this species may be native to Lone Tree Creek in Wyoming. The status of orangethroat darters in the Platte Basin in Wyoming was unknown until the 1990s. This species was found in Lodgepole Creek, a tributary to the South Platte River, in the late 1960s when the stream was treated with a piscicide in an effort to remove non-game species (Stone and Baxter 1995). Results of attempts to reintroduce the species following chemical treatment remained uncertain until 1993, when they were found in abundance at two of three sampling locations on Lodgepole Creek.

While our sampling regime prohibits conclusive statements regarding those species that may be expanding in range, some species appeared in substantially more sites and streams during the 1990s survey than during the 1960s survey. This suggests that either these species are much more susceptible to electrofishing gear than to seines or that they have increased their distribution since the 1960s. Species that exhibited large increases include common carp, johnny darters, and central stonerollers (Table 3). We found two of these species, Johnny darters and central stonerollers, easy to capture with seines. Young-of-year common carp were also relatively common in our seines. Consequently, we believe these species are expanding their distributions within the Platte River basin in Wyoming.

In conclusion, over half (17 of 33) of the fishes captured during surveys conducted in the 1960s and 1990s have exhibited changes in distribution. Seven species have experienced appreciable reductions in distribution and one species (lake chub) may have been extirpated from the drainage. We hope that this and future survey efforts and analyses will help resource managers identify those species in need of protection prior to irreversible imperilment.

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Fish Species Composition in the Central Platte River, Nebraska

James W. Chadwick, Steven P. Canton, Don J. Conklin, Jr., and Paul L. Winkle, Chadwick Ecological Consultants, Inc., Littleton, Colorado

Fish populations in the central Platte River, Nebraska, were sampled from 1987-1995 as part of several studies sponsored by the Central Nebraska Public Power and Irrigation District and the Nebraska Public Power District. The fish community is dominated by cyprinid taxa, with catostomids, ictalurids, and centrarchids also common. Comparisons between the species composition for the present study and three other studies conducted over the last 50 years indicates that fish species composition in the central Platte River has not changed appreciably over time. A diverse fish assemblage comprised of 58 species has been found over the four studies, with large overlaps in species found between studies. There is considerable similarity between the fish assemblages present in the central Platte River prior to 1942 and those collected during 1987-1995, using the Coefficient of Community index. Similarities between these two studies that are 50 years apart were 70% for presence/absence of all species, and 89% for the cyprinid species. A comparison of the present study to a recent study on the lower Platte River indicates that the species composition in the lower Platte River is similar in many respects to that of the central Platte River, although the fish community in the central Platte River may be somewhat more diverse. These data indicate a high degree of resilience in the fish populations of the central Platte River over time, despite a varitey of disturbances.

Distribution, Habitat Use and Food Habits of Sturgeon in the Lower Platte River, Nebraska

Robin L. Hofpar and Edward J. Peters, University of Nebraska-Lincoln, Department of Forestry, Fisheries and Wildlife, Lincoln, Nebraska

Shovelnose sturgeon (*Scaphirhynchus platorynchus*), pallid sturgeon (*Scaphirhynchus albus*), and lake sturgeon (*Acipenser fulvescens*) have all been documented in Nebraska from the Missouri River and lower reaches of the Niobrara, Platte, Elkhorn, and Nemaha rivers. Declines of all sturgeon populations and the recent listing of pallid sturgeons as a Federally Endangered Species has promoted interest in their habitat selection, food habits, and overall biology. To study sturgeon populations in the lower Platte River, six sampling sites were established between the confluence of the Platte and Missouri rivers and the mouth of the Loup River at Columbus, Nebraska, approximately 160 km upstream. Sturgeon populations were sampled between July and Octeber, 1995, using drifted gill nets and stationary gill net sets. Habitat measurements (depth, mean column velocity, bottom velocity, substrate, cover, dissolved oxygen, water temperature, and turbidity) were taken to describe each habitat sampled. Stomach contents were sampled from sturgeon using pulsed gastric lavage (PGL). At locations where collected, depths ranged from 15-212 cm (mean=70.4), mean column velocities ranged from 9-75 cm/sec (mean=51.1), bottom velocities ranged from 3-75 cm/sec (mean=30.8), turbidities ranged from 15-.500 NTU's and water temperatures ranged from 30.9 C in July to 5.9 C in Ocyober. Diptera larvae, primarily the family chironomidae made up the majority of their diet, but Ephemeroptera, Trichoptera, Hemiptera, and Coleoptera were also found. Sampling will resume in March and continue through the fall of 1996.

An Ichthyological Survey of the North and South Platte Rivers in Western Nebraska

John D. Lynch and Brian R. Roh, University of Nebraska-Lincoln, School of Biological Sciences, Lincoln, Nebraska

An ichthyological survey (1989-1995) of 31 sites on the North Platte (20 sites) and South Platte (11 sites) rivers plus immediately below the North Platte diversion dam resulted in the capture and documentation of the distributions of 46 species of fishes (two clupeids, one salmonid, six catostomatids, 15 cyprinids, four ictalurids, two fundulids, one poeciliid, one atherinid, one gasterosteid, seven centrarchids, one percichthyid, four percids, and one sciaenid). Four other species (*Salmo trutta, Ameiurus natalis, Noturus gyrinus, and Etheostoma exile*), found in the drainage, were captured in tributary streams only. Esox lucius was found only sporadically along the North Platte River and was not vouchered in our surveys. Forty-nine sampling visits were made of the 32 localities (12 above and eight below Lake McConaughy on the North Platte River and 12 on the South Platte River) yielding some 55,000 preserved voucher specimens of the 46 species. We also used distributional data based on an additional 42.000 specimens captured, identified, and released at17 localities. Including nonvouchered records obtained by ichthyology classes, the twelve sites on the North Platte River above Lake McConaughy harbor 15 to 29 species of fishes (39 species taken in total) whereas the eight sites on the North Platte River below Lake McConaughy harbor 17 to 29 species (34 species taken in total and the twelve sites on the South Platte River harbor 19-33 species (37 species taken in total).

AN ICHTHYOLOGICAL SURVEY OF THE NORTH AND SOUTH PLATTE RIVERS IN WESTERN NEBRASKA

John D. Lynch and Brian R. Roh, University of Nebraska-Lincoln, School of Biological Sciences, Lincoln, Nebraska

An ichthyological survey (1989-1995) of 31 sites on the North Platte (20 sites) and South Platte (11 sites) rivers plus immediately below the North Platte diversion dam resulted in the capture and documentation of the distributions of 46 species of fishes (two clupeids, one salmonid, six catostomatids, 15 cyprinids, four ictalurids, two fundulids, one poeciliid, one atherinid, one gasterosteid, seven centrarchids, one percichthyid, four percids, and one sciaenid). Four other species (Salmo trutta, Ameiurus natalis, Noturus gyrinus, and Etheostoma exile), found in the drainage, were captured in tributary streams only. Esox lucius was found only sporadically along the North Platte River and was not vouchered in our surveys. Forty-nine sampling visits were made of the 32 localities (12 above and eight below Lake McConaughy on the North Platte River and 12 on the South Platte River) yielding some 55,000 preserved voucher specimens of the 46 species. We also used distributional data based on an additional 42.000 specimens captured, identified, and released at17 localities. Including nonvouchered records obtained by ichthyology classes, the twelve sites on the North Platte River above Lake McConaughy harbor 15 to 29 species of fishes (39 species taken in total) whereas the eight sites on the North Platte River below Lake McConaughy harbor 17 to 29 species (34 species taken in total and the twelve sites on the South Platte River harbor 19-33 species (37 species taken in total).

Dominant species (combining North and South Platte rivers), in order of abundance, are: Notropis ludibundus (30.8%), Hybopsis dorsalis (28.6%), Hybognathus hankinsoni (13.2 %), Hybognathus placitus (7.7%), Pimephales promelas (4.8%), Cyprinella lutrensis (3.1%), Semotilus atromaculatus (2.4%), and Fundulus zebrinus (2.0%). Their respective incidences (of 32 sites) are 32, 32, 21, 8, 30, 25, 30, and 27.

Above Lake McConaughy, the North Platte River is dominated by five species (Cyprinella lutrensis [3%], Hybognathus hankinsoni [21%], H. Placitus [14%], Hybopsis dorsalis [14%], and Notropis ludibundus [21%]) whereas below Lake McConaughy, the fish fauna of the North Platte River is dominated by only four species (Catostomus commersoni [2%], Cyprinella lutrensis [6%], Hybopsis dorsalis [38%], and Notropis ludibundus [43%]). The South Platte fish fauna is dominated by six species (Cyprinella lutrensis [2%], Hybopsis dorsalis [34%], Notropis ludibundus [32%], Pimephales promelas [5%], Semotilus atromaculatus [4%], and Fundulus zebrinus [3%]).

The two units on the North Platte River are each divisible into eastern and western sections, based on the compositions of the fish faunas. The western Upper North Platte is dominated by four species (Cyprinella lutrensis, Hybognathus plalcitus, Hybopsis dorsalis, and Notropis ludibundus) whereas the eastern section is dominated by six species (Carpiodes cyprinus, Cyprinella lutrensis, Hybognathus hankinsoni, H. Placitus, Notropis ludibundus, and Pimephales promelas). The western Lower North Platte is dominated by four species (Catostomus commersoni, Hybopsis

dorsalis [56%], Notropis ludibundus [6%], and Semotilus atromaculatus) and the eastern Lower North Platte by only three (Cyprinella lutrensis, Hybopsis dorsalis [29%], and Notropis ludibundus [45%]). The eastern and western divisions are attributed to effects of the impoundment of the North Platte River by Lake McConaughy. Recent (1995) work on the South Platte River also suggests the existence of eastern and western subdivisions, but those subdivisions were not evident 10-20 years ago.

Only three species were taken at single sites (Ictiobus cyprinellus at station 31, Pylodictis olivaris at station 32, and Etheostoma nigrum at station 1). Five other species have restricted distributions in the system: Ameiurus natalis and Noturus gyrinus are known only from Whitehorse Creek (Lincoln County), Etheostoma exile is known only from Cedar Creek (Keith County), Labidesthes sicculus is restricted to the five easternmost stations, and Luxilus cornutus is known only from Scottsbluff County (North Platte River and several tributary streams). In contrast to the situation on the Middle Platte, Gambusia affinis remains uncommon in the upper Platte (relative abundance 1%) but is ubiquitous.

Designing Hydroperiods for Riparian Wetlands in Wyoming and the Impliations for River Management

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Since 1987, the University of Wyoming Water Resources Center and the Department of Rangeland Ecology and Watershed Management have been investigating ways to link the response of riparian-plant species to their supporting hydrology. This information is vital for developing ecologically based management plans that protect the environmental integrity and function of riparian areas, while continuing to support other benefits to society.

The optimum hydroperiods (surface and groundwater levels) for three riparian plant species/assemblages were determined by using hydroperiod suitability curves based on information collected from field sites in southeastern Wyoming. These curves suggest the expected plant response, such as biomass or density, to specific watertable levels during the growing season, and can be used to design hydroperiods for constructed and restored riparian wetlands. A nearly constant 15 cm of standing water throughout the growing season was optimum for sedge biomass. Tufted hairgrass biomass was optimized when the early season water table was 17 cm deep, mid season water table was at 121 cm, and late season water table was at 179 cm. Slimstem reedgrass did not appear to have a strong relationship with the hydroperiod.

To confirm the field results, laboratory experiments are being conducted at the University of Wyoming using 90, 3-m tall columns in which the water tables are precisely controlled without adding water from the surface. Sand is used as the growth medium to limit other potential sources of water for the plants, such as from capillary fringe or from residual moisture left above the declining water table. Five groundwater decline rates (0, 1, 2, 4, 6 cm*day) with an initial level at the surface, and three maximum groundwater depths (1, 2, 3 m) were used to simulate natural hydroperiods, as well as hydroperiods that might be expected from streamflow diversions. Plant response to the various hydrologic regimes is determined by measuring the following attributes: above and below ground biomass, average leaf length, number of live leaves, number of shoots/sprigs, root density, and maximum root depth.

Preliminary results from the laboratory study suggest that Nebraska sedge, tufted hairgrass and Kentucky bluegrass can not survive for more than 20 days if the water table drops below 40 cm. Since tufted hairgrass and Kentucky bluegrass can occur where the water table drops below 40 cm during the growing season, other sources of water besides the water table may be important for their survival. These other sources, such as precipitation, should also be considered when water reallocations, like those for the Platte River, are considered for riparian habitat improvement.

Water Quality in a Wet Meadow, Platte River Valley, Cental Nebraska

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The Platte River Valley in Nebraska, and in particular the reach from Kearney to Grand Island, is an extremely important natural habitat area. Over 300 migratory bird species, including several threatened and endangered species, have been observed along the Platte River. In the spring, nearly 500,000 sandhill cranes, along with millions of ducks and geese, use this reach as a staging and feeding area during their northerly migration. Wet meadows (grasslands which have waterlogged soils much of the year) are a critical part of this migratory-bird habitat. However, the area of wet meadows between Kearney and Grand Island has declined nearly 50 percent due to the activities of man. The condition of the remaining wet meadows is of vital importance.

The U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program is designed to describe the status and trends in the quality of the Nation's surface water and groundwater resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources. A study of the groundwater beneath a selected wet meadow was undertaken as part of the Central Nebraska Basins NAWQA study unit.

Observation wells were installed in the wet meadow at various distances along two transacts downgradient from the edge of a corn field. One to five wells completed at depths of about 15 to 100 feet were located at each of the 5 sites. The wells were completed in the Platte River alluvium or the underlying Ogallala Formation. The depth to the water table ranges from 0 to 5 feet below land surface. The general direction of groundwater flow is parallel to flow in the Platte River. Selected wells were sampled in February, March, June, and December 1994 for major cations and anions, nutrients, and organonitrogen herbicides.

Pesticides and fertilizers are used extensively in Nebraska to enhance the production of row crops. Some of these pesticides and fertilizers have migrated into the groundwater. Atrazine was detected in water from all of the wells sampled in February and June and most of the wells sampled at other times, but only in concentrations of 0.1 to 0.6 micrograms per liter. Concentrations of the other pesticides analyzed, including alachlor, cyanazine, and metolachlor, were at or below the detection limit of 0.05 micrograms per liter. The highest concentrations of nitrate were found in water from the shallow wells (about 15 feet deep). The concentrations of nitrate as nitrogen in water from these wells ranged from 5 to 13 milligrams per liter in June.

Concentrations of major cations and anions decreased and their ratios varied with depth. The major cations were calcium and sodium, and the major anions were sulfate and bicarbonate. Water from the shallowest wells was a mixed calcium sodium sulfate type, whereas the deepest alluvial-aquifer water was a calcium sulfate type. The water from the Ogallala Formation was a calcium bicarbonate type. The variability of the groundwater quality reflects seasonal changes in recharge to and evapotranspiration from the alluvial aquifer and rates of movement and mixing within and between the aquifers.

A Plant Study and Comparison of Upland Cemeteries to rangelands in Buffalo County, Nebraska

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The mixed-grass prairie of the central Nebraska Loess Hills evolved with ungulate grazing and periodic prairie fires. When the Europeans settled this area of Nebraska the native ungulates (mainly *Bison bison*) were killed and domesticated cattle were introduced. Settlers also suppressed the prairie fires. These changes affected the native prairies. Settlers established cemeteries (90-110 years ago) that were fenced and not grazed, just mowed. Seventeen of these cemeteries on upland sites in Buffalo County, Nebraska, were surveyed fro their plant species composition abundance and soil compaction data were also taken, These data were then statistically compared to rangeland (grazed) sites that had data taken using the same procedures. Cemeteries had a total of 105 different plant species and averaged 23 different plant species while rangelands averaged 37. The total biomass of cemeteries was comprised of significantly more *Andropogon gerardii, Bromus inermis*, decreaser plant species, less *Ambrosia psilostachya*, increaser plant species, and forb biomass than rangeland sites. A coefficient of similarity was used to compare the cemeteries' range condition to the best 9 of 279 range prairie sites. The cemeteries ranged from 7% to 98%, similar to the best range sites. Cemeteries were found to be significantly less compact than rangelands at depths of 3, 6, 9, 12, and 15 inches and more compact at 21 inches.

A PLANT STUDY AND COMPARISON OF UPLAND CEMETERIES TO RANGELANDS IN BUFFALO COUNTY, NEBRASKA

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Introduction

Rangeland is defined as land where people have intervened to manage the vegetation with livestock for economic gain. Using this definition, rangelands encompass 47% of the earth's land area (Heady, 1975; Menke and Bradford, 1992) and 57% of Nebraska's land area is grassland or rangeland (Stubbendieck and Reece, 1992).

This study compared native prairie that has only been mowed to range sites that have been grazed. The intent of this research is to identify the differences and similarities of cemeteries and rangelands and to show how mowing with no grazing or fire has affected the mixed-grass prairie of central Nebraska.

The main effect of grazers on grasslands is that grazers remove living parts of plants. Grazers are selective in what they find palatable (Tomanek et al., 1958). If a plant species is not palatable, grazers will not consume it. Hence, a grazed grassland will have some species that are more prevalent than others due to this selective grazing. The species that are not grazed tend to grow better because they are undisturbed and can compete well with or even outcompete neighboring plants for water and nutrients. Grazing is known to have an impact on the whole ecosystem. Herbivores do more than just defoliate plants. They compact the soil by hoof action, remove and redistribute nutrients, create different levels of system disturbance, and impact colonization of plants. Plant responses to herbivory are affected by past history, interactions among biotic and abiotic components, and current environmental conditions. Much research in these areas needs to be conducted before any definitive answer can be reported.

Overgrazing tends to shift the balance of species abundance. Ungrazed species usually tend to increase while heavily grazed species tend to decrease in abundance. Some plants tend to decrease consistently in response to increased grazing intensities (‘decreasers') while others increase consistently (‘increasers') and some species only appear above a certain grazing intensity (‘invader') (Noy-Meir et al., 1989).

Grazing simulation experiments are often conducted to determine the effect of defoliation on plants. These experiments often employ clipping or mowing plants. It is often assumed that clipped plants respond the same as grazed plants. Rarely is this the case. Whitman et al. (1961) reported that clipping resulted in more severe injury to grass stands than does defoliation by grazing. Clipping or mowing does not simulate the selectivity of a grazing animal for or against a plant species. Mowing also lacks the nutrient recycling and trampling effects of grazing animals.

A study in eastern Nebraska by Hover and Bragg (1981) suggests that over time, summer mowing will tend to increase the dominance of cool season species whereas spring mowing will increase warm season species. There has been research on mowing effects of plant production and composition in native bluestem prairies (Ehrenreich, 1959), but long-term effects of mowing on mixed-grass prairies are not well documented for Nebraska. In Gage County, Nebraska, Conard and Arthaud (1957) found that the total forb population decreased 19% under six years of July mowing compared with increases of 49% and 87% under mid-August and late September mowing, respectively and that the average density of the grass and grass-like vegetation increased approximately 25% during the same six-year period (1946-1951).

Since the intrusion of European settlers on the Great Plains many changes have occurred which have altered the original grassland that was present. Buffalo used to roam the plains in their migratory patterns in numbers reported as high as 60 - 70 million (Shaw, 1995), but perhaps a more reasonable estimate is 30 million (McHugh, 1972) based upon potential stocking rates of the Great Plains. But the settlers drove the species to near extinction by the mid 1880's. The plains were then utilized by domesticated cattle and were eventually fenced. This fencing allowed for little movement of the cattle and resulted in a continuously grazed area that routinely was overgrazed. The settlers also plowed up the plains which killed the prairie grasses and also acted as fire breaks (Costello, 1969). This supression of fire allowed shrubs and trees to invade the plains and choke out the prairie vegetation in some areas (Wright and Bailey, 1982). The overgrazing and plowing compounded by drought caused much erosion on the plains in the 1930's (Weaver, 1968). The consequence of all this is a landscape decidedly different than the original.

These changes brought about largely by settlers have prompted much research on Great Plains grasslands directed toward improved management practices. My research focused on the study of prairie cemetery sites in Buffalo County, Nebraska. These cemetery sites were chosen because they are relict prairie areas that have not been grazed since their establishment. The oldest cemeteries were established in the 1880's, prior to the fencing of all private lands. This means that these areas were set aside before the natural prairie environment was altered. These cemeteries were fenced, but they were also cared for and although it is unknown how they were first managed, it is known that they have been mowed several times each year for as long as the sextons contacted can remember (30 - 50 years). All the cemeteries include substantial land area that was not disturbed by graves, vehicles or other heavy human impact. Another key point regarding cemeteries is that they have not been grazed.

The purpose of this project was to inventory the plant species of upland cemeteries in Buffalo County. Once obtained, the inventories were compared to those of upland range sites. The upland range sites are used primarily for cattle grazing. These range sites have been grazed for over 100 years and due to different management practices, create a mosaic of plant communities. Cattle may overgraze certain areas of a pasture introducing extreme disturbance while other areas of the pasture may not be grazed at all. This unequal use can be the result of variable plant species' palatability, water location, supplementary mineral location, fence location, and pasture terrain. Some of the range sites contain tracts that were once farmed, but were planted back to native grasses or just left fallow and over time plant species encroached and established themselves.

Study Site

The cemeteries sampled were located in Buffalo County, Nebraska (Figure 1). The county has a land area of 952 square miles (2,418 km2) which is 609, 280 acres (246,758.4 hectares) (Buller et al., 1974). Of this area, 52.6% is farmed in dryland or irrigation, 37% is grassland, and 9.9% is urban, suburban, roads, and wastelands (Anonymous, 1995).

Buffalo County is located in a region known as the Loess Mixed-grass Prairie (Kaul and Rolfsmeier, 1993) or Central Nebraska Loess Hills (Stubbendieck and Reece, 1992) (Figure 1). Loess is fine-grained material primarily of silt-sized particles (0.002 - 0.05 mm) that has been deposited by wind and most of the loess in the county is Peoria loess (Buller et al., 1974). Mixed-grass prairie is grassland that derives its name from the assumption that the original plant cover was composed of mid and short grasses of approximately equal density (Weaver, 1965; Weaver and Clements, 1929).

Buffalo County's climate is continental characterized by wide seasonal variations with winter temperatures below 0 °F (-17.8 °C) and summer temperatures above 100 °F (37.8 °C) having an average annual temperature of 50.5 °F (10.3 °C). Average precipitation at Kearney is 23.9 inches (607.1 mm). Eighty percent of this precipitation falls from April to September. The average snowfall for a year is 27 inches (685.8 mm). (National Weather Service, United States Department of Commerce)

County History

What is now Buffalo County was once the hunting ground and home of the Pawnee Indians (Bassett, 1916). The first European settlers in Buffalo County were Mormons who settled on the Wood River in 1858. At this time , the American buffalo (Bison bison) was plentiful and no domesticated cattle were to be found. However, in the early 1860's ranches were started and the county was free range.

In 1866, the Union Pacific Railroad was completed through the Platte Valley in Buffalo County and this brought in more settlers. The county was organized in 1870 and by 1874 the population was 3,000 (Andreas, 1882). These new settlers took homesteads of 160 acres (64.8 hectares) and part of this was plowed for crops. By 1890, most of the land was homesteaded and the fencing of land was commonplace (Weaver and Bruner, 1948).

Stocking rates of rangelands during this time through 1930 were probably higher than they should have been. During the drought of the 1930's the pastures were denuded and bare ground was very prevalent. Overgrazing and drought taught many cattle raisers of Buffalo County that grazing needs to be regulated. Today the stocking rate most commonly used is 5 to 7 acres (2.025 - 2.835 hectares) per animal unit, which will vary depending on the environmental conditions and cattle prices.

Materials and Methods

Cemeteries were sampled in Buffalo County, Nebraska in June and July of 1995. These cemeteries were all located on upland sites. Upland sites were chosen since most rangeland sites in Buffalo County are upland sites. Furthermore, most lowland communities including Kearney, Gibbon, and Shelton have cemeteries that are continually maintained and possess few of the features of a native prairie.

These cemetery sites are a subset of 360 sites sampled in rangeland locations in the Central Platte Natural Resources District (CPNRD) (Figure 2). All but seven of these sites were located in Buffalo and Dawson Counties. The objective of the CPNRD study (Nagel et al., 1995) was to collect plant species data from rangeland locations. This research was conducted during the summer's of 1993-1995.

Sampling methods consisted of two or three trained botanists walking throughout the cemetery for ten minutes recording all plant species observed. Most sampling areas had not been disturbed with any interments or the foot traffic that accompany them. However, in the smaller cemeteries, the entire cemetery was sampled. These smaller cemeteries were old cemeteries (established 1880's) and most of the vegetation around the gravestones was native. After ten minutes, the botanists estimated the biomass of these species and recorded them as a percentage of the total biomass that would be present when all species had achieved full growth. Any unknown plant species were brought back to the laboratory for identification.

At each field site in the field, a latitude and longitude reading was taken with a Magellan (global positioning system) Nav Pro 5000 (Magellan Systems Corporation, 960 Overland Court, San Dimas, CA 91773). Also in the field, notes were taken on the general appearance of the site. For example, if smooth brome (Bromis inermis Leyss.) was present in the road ditch contiguous to the site, this was noted on the field sheet.

Soil samples were also taken at each native range site in the summer of 1995. Including cemeteries and pasture/rangeland sites, a total of 81 native range sites were sampled. Soil compaction readings were taken with a soil compaction tester (Dickey-john Corporation, Auburn, Illinois 62615) with a 1/2 inch tip. Some sites were so desiccated that no soil cores could be taken.

All data were entered into a Microsoft Excel 5.0 spreadsheet program. This spreadsheet contains site size, legal description, latitude and longitude, past land use, tall grass biomass, short grass biomass, forb biomass, invader biomass, and C3/C4 biomass of the sites sampled. The spreadsheet contains 264 columns of which 213 columns are for plant species.

Cemeteries are open to the public so permission was not needed to sample these sites. However, all sites on privately owned land were sampled only after the consent of the land owner was obtained. In order to determine management practices for each cemetery, I contacted the sexton of every cemetery by telephone. I acquired the land area of each cemetery at the Buffalo County Deeds office.

Soil series were determined from the Buffalo County Soil Survey Manual (Buller et al., 1974) and the elevation of each cemetery was determined from United States Geographical topographic maps.

A t-test (Zar, 1984) was used to analyze soil compaction data at 3, 6, 9, 12, 15, 18, and 21 inches from cemeteries versus rangelands sampled in 1995. This test was performed to determine if there were any statistically significant differences in soil compaction between cemeteries and rangelands at the different depths.

A reference site range condition method (Wilson, 1984) was used to rate the nativeness and condition of the cemeteries sampled. Horn's (1966) modification of Morisita's (1959) index of community similarity was calculated for each cemetery using the NTSYS (Numerical Taxonomy and Multivariate Analysis System; Exeter Software, 100 North Country Road, Setauket, NY 11733) computer software. This index of similarity compared how similar the cemeteries were to the best nine of 279 range/prairie sites sampled based on a clustering analysis using 100% Andropogon gerardii . Cemeteries were then compared to these nine reference sites using the thirty dominant species that comprised most of the total biomass (Table 1). Morisita's index gives a value from 0.0 (no similarity) to 1.0 (identical) and was chosen because it is affected little by sample size.

A multiple regression analysis (Zar, 1984) was performed using the maximum reference site percentage as the dependent variable and the year established, the number of people interred (disturbance), cemetery size in acres, number of times mowed per year, and whether or not clippings were removed after mowing as the independent variables.

A t-test was also performed to statistically determine any differences in the floristic composition of cemeteries versus rangelands sampled the summer of 1995.

Results

Cemeteries were found to be mowed from as few times as once a year to as many as 7-8 times a year (Table 2). The sextons of Dove Hill Cemetery and Old Zion Cemetery could not be contacted, therefore the exact number of mowings per year is not known (1). Only three cemeteries had clippings from mowings left on them (Table 2). General information collected on each cemetery is of historical and ecogeographical interest (Table 2) since no one has ever compiled these data before.

Rainfall for the growing seasons (April - September) for the summers sampled are: 1993, 27.54 inches (699.5 mm); 1994, 17.81 inches (452.4 mm); and 1995, 19.24 inches (463.3 mm), thus water availability was not a limiting factor these years on mixed-grass prairie production since these amounts represented 80% to more than 100% of the annual total.

A combined total of 105 different plant species were found and identified on all 17 cemeteries and contained both native and introduced plant species.

Maximum coefficient of similarities of the cemeteries based on 30 plant species correlated to the best nine sites (reference sites) of 279 sites sampled gave values ranging from 7% to 98% similar (Table 3). Average reference site similarity is the mean of how each cemetery compared in similarity to all nine reference sites whereas the maximum reference site similarity value is the maximum similarity of each cemetery to any one of the nine reference sites. The mean range condition for the 17 cemeteries based on the nine reference sites was 49.2 ± 24.7%, while the mean of the average range condition for 62, 1995 rangelands based on the nine reference sites was 27.5 ± 23.8%.

Multiple regression analysis showed that clippings (left or removed), the number of people interred, the average year people were interred, land area of cemeteries, or the number of times mowed per year upon maximum range site similarity of the cemeteries were not significant (p-values all >0.3). A correlation of the number of times mowed versus the maximum reference site similarity value for each cemetery gave a negative correlation of 0.413 which was not significant ($p=0.1257$).

Penetrometer data between the cemeteries and rangelands was shown to be significantly different at all depths except 18 inches (Figure 3). The cemeteries were less compacted from the surface to a depth of 15 inches than the rangelands. At 18 and 21 inches, the cemeteries were more compacted with a significant difference at 21 inches.

As expected, plant composition of the cemeteries and rangelands was shown to be significantly different (Figure 4). Examples of ‘decreaser' plants in Buffalo County are Andropogon gerardii, Psoralea esculenta, Panicum virgatum, and Stipa comata. ‘Increaser' plants are Agropyron smithii, Andropogon scoparius, Buchloe dactyloides, and Callirhoe involucrata, and ‘invader' plants are Bromus inermis, Poa pratensis, Bromus tectorum, Medicago lupulina, and Ambrosia psilostachya.

Discussion

Plant species composition of cemeteries was found to differ from grazed rangelands. This was expected due to different management practices. Mowing clips all plants to the same above ground height with no discrimination among plants. This lack of selection could explain why cemeteries on average contained 23 different plant species whereas grazed rangelands contained 37 different plant species and also the smaller land area of the cemeteries accounts for some of the difference. Many non-palatable plants may not be able to withstand defoliation because they are rarely defoliated and have not evolved a coping mechanism for recovery after defoliation. An example of two species that are unpalatable to grazers due to their bitter taste are Verbena stricta andVernonia baldwinii (Farrar, 1990). These plants are often abundant increasers on overgrazed rangelands. However, both species were only found on three cemeteries and even then only one or two plants of each were found. Another plant species that was found on only one cemetery but is abundant on overgrazed rangeland is the invader Ambrosia psilostachya. Forbs usually have their meristematic regions (growing points) above ground whereas a grasses' meristematic region is at or below ground level (Branson, 1953). This phenomenon could account for the decreased forb biomass on cemeteries (8%) as compared to rangelands (19%). Many forbs are increasers and the nonselectivity of mowing could account for the significantly lower ($p=0.0001$) percentage of total increaser biomass on the cemeteries.

Decreasers made up a significantly larger percentage of the biomass on cemeteries than on rangelands. Lack of discrimination by mowers, caused the retention of decreaser species. Combined with fewer increaser plant species they were thus able to successfully compete with other plant species. Andropogon gerardii is the most important decreaser plant species on the mixed-grass prairie of central Nebraska. It's total biomass was higher on cemeteries and thus was the greatest contributor to the decreaser biomass.

Some grasses are more susceptable to grazing than other grasses due to the location of their growing point. For example, Panicum virgatum's growing point is above the ground early in the growing season whereas Andropogon gerardii's growing point is below the ground until late in

July (Branson, 1953). This difference in location of growing points can account for only one occurrence of Panicum virgatum on the cemeteries sampled. This location of growing points along with mowers removing all tillers can account for the low occurrence of Andropogon scoparius on cemeteries.

Poa pratensis is a very aggressive, introduced invader that has invaded all sites across Nebraska (Stubbendieck et al., 1985) whereas Bromus inermis, also an introduced invader, has not invaded all sites. Used primarily as a soil stabilizer in road ditches, Bromus inermis has encroached onto adjacent prairies. However, in most cases it has just encroached across the fences into the prairies. The cemeteries were typically small and also were near country roads and the significantly higher percent biomass of Bromus inermis is probably then not due to mowing or non-grazing.

Soil compaction changes the soil's bulk density and thus alters the infiltration rate of water through the soils (Abdel-Magid et al., 1987). Cemetery soils were less compact in the top 15 inches than were rangelands. This difference can be accounted for by hoof action on the rangelands. Why cemeteries are more compact at 18 and 21 inches could be because of a hardpan or caliche layer. However, the reason for this compaction deeper than 15 inches needs further research.

Much research has been done on diversity and overall it has been found that the structure of a grassland community cannot be actually determined without considering the structure of the natural disturbance regime (Denslow, 1980). Collins and Barber (1985) found that species diversity was low on the undisturbed and most severely disturbed grasslands of mixed-grass prairie. However, they also found that grassland diversity was not a simple function of disturbance rate, size, or intensity, but that species diversity was maximized under a combination of natural disturbances. Therefore, further research on cemeteries and rangelands and their disturbance regimes needs to be conducted before the effects of disturbance upon their plant species diversity can be reported.

Cool-season grasses, particularly the introduced species, are severely harmed by spring burning. Poa pratensis and Bromus inermis are both cool-season, introduced grasses. It has been shown that early spring burning inhibits Bromus inermis and that Poa pratensis was decreased by 80% or more (Old, 1969). However, Nagel et al. (1994) found that Bromus inermis composition on Willa Cather Prairie was not affected by burning. Therefore, if cemeteries were burned in the spring, Poa pratensis should decrease and perhaps due to the timing of the burn, Bromus inermis might also decrease. If these cool-season grasses decreased, there would be less competition among plants and native species should be able to increase in density.

Cemeteries proved to be very similar (98%) yet at the same time quite different (7%) in comparison with grazed rangelands. This may not be surprising since grasslands are very intricate systems that are affected by not only above-ground influences, but also by below-ground influences. Man and nature are constantly altering the environment of grasslands which further exacerbates understanding the intricacies of the grassland system and makes their study an ongoing process.

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Irrigation Water Conservation Practices for the Central Platte Valley, Nebraska

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Computer simulation models were used to evaluate water conservation strategies for center pivot and furrow irrigated fields in central Platte valley of Nebraska. Irrigation requirements, grain yield, return flow and net depletion of groundwater were simulated for a period of 29 years for Hord and Wood River silt loam soils. Grain yields under non-limit irrigation season (maximum attainable yield), two levels of deficit irrigation where irrigations were limited to certain crop growing periods, and non-irrigated conditions were simulated for corn with 2750 growing degree day requirement (GDD). Additional simulations were performed using a short-season corn (2600 GDD). Grain sorghum, and soybeans. On a Hord silt loam, applied water depths were reduced by 75-125 mm by using deficit irrigation with only a small reduction in yield. Return flow to the ground water was small for well managed pivots but high for some furrow irrigation systems. Net depletion (gross irrigation minus return flow) of the groundwater for a center pivot with a LEPA sprinkler package was 17% less than a center pivot with impact sprinklers. Ridge till had a net depletion 25% less than conventional tillage (double disk, then plant) for the furrow systems.

IRRIGATION WATER CONSERVATION PRACTICES FOR THE CENTRAL PLATTE VALLEY, NEBRASKA

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ABSTRACT

Water conservation strategies for center pivot and furrow irrigation in the Central Platte Valley of Nebraska were evaluated using computer simulation. Irrigation requirements, grain yield, return flow and net depletion of groundwater were simulated for a period of 29 years for Hord and Wood River silt loam soils. Grain yields were simulated for a typical corn variety for non-limiting water supplies (maximum attainable yield), for two levels of deficit irrigation where irrigation was limited to certain growing periods, and for dryland conditions. Additional simulations were performed for a short-season corn, grain sorghum, and soybeans. The impacts of tillage practices on water conservation were also investigated.

Center pivot irrigation on the Hord silt loam required 75-125 mm/yr less water application than furrow irrigation. For the Wood River silt loam, water applications were the same for both irrigation systems. Applied water depths were reduced by an additional 75-125 mm using deficit irrigation with only a small reduction in yield. Return flow to the groundwater was small for well managed pivots but high for some furrow irrigation systems. Net depletion (gross irrigation minus return flow) of the groundwater for a center pivot with LEPA sprinkler was 50 mm less (17%) than a center pivot with impact sprinklers. Ridge till had a net depletion 50 mm less (25%) than conventional tillage (double disk, plant) for the furrow systems.

INTRODUTION

Changing economic and environmental concerns in irrigated agriculture has caused reevaluation of irrigation water usage in central Nebraska. The Central Platte Valley of Nebraska is heavily irrigated using groundwater. There are over 320 000 ha irrigated in a four-county region (Ron Bishop, Central Platte Natural Resources District, personal communication). Corn is the dominant crop and is irrigated for maximum production. Two major concerns in the area are the lowering of groundwater levels and the reduced stream flows in the Platte River. There is interest in water conservation to reduce net depletion of groundwater. Net depletion is defined as water withdrawn minus water that returns to the groundwater reservoir (CAST, 1988).

The term "water conservation" has many meanings. Hydrologically, the focus is on the water balance of either a field or larger area such as a watershed or river basin. Water inputs to a region must equal the water outputs. Inputs include precipitation, available soil moisture, and applied irrigation water. Outputs include crop evapotranspiration (ET), evaporation, deep percolation, leaching requirement, and runoff. One way to reduce overall water usage (conservation) is to reduce the applied water. To reduce applied water one or more of the outputs must be concomitantly reduced, e.g., reducing ET.

ET can be reduced by reducing one of its components, evaporation or transpiration. Crop yields are usually not affected when soil water evaporation is reduced. When evaporation is reduced, the potential for groundwater recharge increases and/or for crop transpiration increases. Conservation tillage systems have lower soil water evaporation than clean tillage systems because of the partial surface cover by crop residues. Thus, conservation tillage is often thought of as a water conserving practice.

Transpiration can be reduced by purposely limiting the available soil water so that plant stress occurs. This practice is often refereed to as deficit irrigation. Crop yield is reduced with deficit irrigation. An alternative method for reducing transpiration is to produce less water intensive crops. In central Nebraska, alternative crops that have a lower ET than corn include grain sorghum and soybeans. When deficit irrigation or different cropping systems are used to conserve water there are economic impacts that must be considered.

Improving irrigation technology to increase irrigation system efficiency is another approach for conserving water. The goal is to reduce the "losses" associated with irrigation: evaporation, runoff, and deep percolation. Furrow irrigation, using gated pipe, is practiced on about 90% of the irrigated area in the Central Platte Valley. To avoid runoff losses from a field, which is a legal requirement in Nebraska, it is common to block or dike the downstream end of the furrows so that all runoff is retained on the field. Improved systems that are considered for water conservation include furrow irrigation with runoff recovery, surge flow furrow irrigation, center pivot sprinkler irrigation, and center pivot LEPA (low energy precision application) irrigation (Lyle and Bordovsky, 1981).

Evaporation from irrigation is assumed to be negligible with furrow irrigation. With sprinkler irrigation, evaporation losses can be the major loss of water during application.

Runoff during irrigation with groundwater can be lost from the aquifer but still be available for use within the watershed or basin (CAST, 1988). As mentioned earlier, irrigators in Nebraska are required by law to prevent runoff from leaving the field boundary. In effect, the runoff must either be reused or must return to the aquifer. With furrow irrigation, efficiency might be higher with runoff recovery when compared to blocked-end systems because water can be applied more uniformly. With well designed and properly managed sprinkler irrigation, runoff should not occur.

Deep percolation, another output, is often considered a loss with irrigation, especially with surface irrigation. However, as pointed out by CAST (1988), deep percolation is only lost when it flows to a salt sink or accumulates in fine textured sediments which makes the water unattainable by wells. In the Central Platte Valley, the groundwater is relatively shallow and deep percolation returns to the aquifer rather quickly without capture in saline sinks or in formations that make it unattainable.

Since the groundwater in the Central Platte Valley is relatively low in salts and the area has a sub-humid climate, leaching requirements with irrigation for salinity management are negligible. It is presumed that deep percolation of rainfall satisfies the needs for salt leaching.

Because of groundwater depletion in the area (Ellis and Wigley, 1988), the Central Platte Natural

Resources District (CPNRD), in cooperation with the U.S. Bureau of Reclamation, has proposed a surface water development/groundwater recharge project to augment the water supply within their district. Since water conservation could be an alternative to a water development project, the CPNRD asked for our evaluation of the impact of potential water conservation practices on net depletion of groundwater. The specific objectives of our project were to:

. Compare applied water, net depletion, and return flow for sprinkler and furrow irrigation systems producing maximum attainable grain yield for field corn in the Central Platte valley of Nebraska.

. Determine the amount of water that is conserved by ridge till versus conventional tillage (double disking, plant) when using a furrow irrigation system.

. Determine the water conserved through deficit irrigation and the associated corn grain yield loss.

. Evaluate applied water, net depletion, return flow, and grain yield for alternative cropping systems for both maximum production and deficit irrigation.

METHODS

In this paper we provide you with only a brief description of the modeling procedures. A paper is currently in press by the authors that explains the details of the modeling. The modeling required linkage of a ET-crop yield model, a soil water balance model, and a surface irrigation model.

Computer simulation models were used to evaluate management systems. A data base containing 29 years of weather data was used to determine responses to irrigation water conservation practices. Several combinations of irrigation and tillage practices were simulated. The performance of a center pivot system with impact sprinklers and a center pivot with low energy precision application (LEPA) nozzles were simulated. LEPA nozzles place water below the canopy. With LEPA irrigation, water is applied much more rapidly than the soil can infiltrate. Thus, interrow tillage which creates micro-basins is required to store water on the soil surface until it has time to infiltrate. The performance of three furrow irrigation systems were simulated: (1) continuous flow irrigation with blocked (diked) ends, (2) continuous flow irrigation with runoff recovery, and (3) surge flow irrigation with runoff recovery. The surface simulations were performed for both conventional and ridge till practices. Conventional tillage in the Central Platte valley of Nebraska usually includes two diskings before planting. Pivot simulations were only performed for conventional tillage practices.

A crop growth soil water balance model (Martin et. al., 1984) was used to evaluate the effect of water stress on crop grain yield, return flow and net depletion. To determine this effect, four lengths of the irrigation seasons were simulated; an irrigation season required to produce maximum yield, two limited irrigation seasons (deficit irrigation), and no irrigation (dryland). The length of each limited irrigation season was defined by the accumulation of growing degree days (GDD). Also in the crop growth model, four crops were simulated: a full season corn (2750 GDD for maturity), a short season corn (2600 GDD for maturity), soybeans, and grain sorghum. The ET component required adjustment for evaporation reduction due to residues on the surface and ET reductions when the crops experienced moisture stress. The approximate tillage dates and crop residue remaining after tillage are given in Table 2. The residue reduction due to tillage was based on data presented by Rawls, et. al. (1980).

In the soil water balance model, runoff from precipitation was reduced by adjusting the SCS runoff curve number using the information presented by Onstad and Otterby (1979). The curve number was 6% less for ridge tillage than for conventional tillage. A final assumption in the soil water balance model is that surface storage of water increased 15 mm because of the presence of micro-basins when LEPA irrigation was used. This storage reduced the amount of runoff from rainfall and irrigation.

Limited irrigation was imposed by shortening the irrigation season. A 5 week season and a 3.5 week season were simulated. The 5 week season began at about vegetative stage 15 (Ritchie et. al., 1986) and ended at beginning kernel dent. The 3.5 week season started at stage R1 and ended at stage R4. These shortened seasons are in contrast to an irrigation season of 9 to 10 weeks that is required for maximum grain production.

Simulations were performed for two soils: Hord silt loam and Wood River silt loam. The water holding properties for these soils, given in Table 1, were obtained from SCS (1983).

The crop model is one dimensional--it simulates a point in space. To account for the non- uniform application depth of a furrow irrigation system, another model, SIRMOD (Utah State University, 1989), was used to create irrigation inputs for the crop model at multiple points in the field.

In the surface irrigation modeling the key adjustments that had to be made were in the infiltration function. Infiltration is a process that has a large influence on the fate and distribution of the applied water. The infiltration function was adjusted for the following: tillage effect (Eisenhauer et. al., 1983), irrigation number, effect of irrigation delay (Encisco, 1993), and the effect of surging (Blair and Smerdon, 1985). The effect of these practices on the infiltration function are shown in Figure 1.

RESULTS

Irrigating for Maximum Grain Yield. Simulation results for grain yield, applied water depth, net depletion, and return flow for center pivot and furrow irrigation on Hord and Wood River silt loam soils are shown in Figure 2. All simulations, with the exception of continuous flow irrigation with runoff recovery, showed yields at the maximum yield of 11900 kg/ha for 2750 GDD corn. Generally, yields for continuous flow irrigation with runoff recovery and a Hord silt loam soil were 1-2% below the maximum. Yield reductions in continuous flow simulations were the result of the irrigation scheduling method. Furrow irrigations were scheduled when the point that represented 90% of the furrow length reached 50% depletion. The remaining 10% of the field exceeded 50% depletion before an irrigation occurred. This often reduced yields in the least watered 10% area.

The center pivot with LEPA nozzles resulted in an applied water depth 8% less than the center pivot with impact sprinklers. Net depletion with LEPA was 17% less than for impact sprinklers. The decrease in net depletion is a result of lower evaporation and the effects of basin tillage. The basins increased the effective rainfall by 26 mm for the season (less runoff).

Applied water depths for the Hord silt loam soil were 28% less for center pivot compared to furrow simulations. Return flow was considerable lower (64% lower) for center pivots than for furrow irrigations. Net depletion was similar between center pivot and furrow irrigations when conventional tillage was used. Results with Wood River silt loam were similar when comparing irrigation systems.

Applied water depths for continuous flow irrigation with blocked ends and continuous flow with runoff recovery were similar. Surge flow irrigation reduced the amount of applied water compared to continuous flow irrigation for Hord soil by 18% and for Wood River soil by 8%. Surge flow irrigation reduced return flow by 40% compared to continuous flow irrigation for the Hord soil and 25% for the Wood River soil.

Tillage Comparison. Ridge till systems consistently showed less net depletion than conventional tillage while grain yield was not affected by tillage practice. The average net depletion for ridge till was 24% less than for conventional tillage (Figure 2). Net depletion for the surge flow irrigation system with conventional tillage and Hord soil was 275 mm while for the same system with ridge till it was only 215 mm.

The water savings (lower net depletion) with ridge till is due to a combination of less rainfall runoff and less soil water evaporation.

Table 3 summarizes the water balance data for two tillage types for a Wood River soil and continuous flow irrigation with blocked ends.

The reduced evaporation is the result of the larger quantity of crop residue on the soil surface. The net affect of the residue and reduced runoff was one less irrigation event for the season and an increased opportunity for rainfall to be included as return flow, thus decreasing the net depletion.

Deficit Irrigation. Results for a limited or deficit irrigation season are given in Figures 3 and 4. Grain yield, applied water, net depletion and return flow for a limited irrigation season of 5 weeks are illustrated in Figure 3. The 5 week season is an approximate length of season while the actual length is controlled by accumulation of growing degree days as explained previously. The results for the 3.5 week limited season are shown in Figure 4.

The 5 week irrigation season resulted in little yield reduction for center pivot compared to irrigating for maximum yield. On a Hord silt loam, limiting the irrigation season to 5 weeks reduced the grain yield compared to the maximum yield by only 2% and for a Wood River soil by only 3%. The hydrologic impacts of the shorter irrigation season were more significant. Applied water was reduced by 19% compared to irrigating for maximum yield for both soil types. Net depletion was reduced by 13% and return flow by 50% compared to maximum yield conditions.

Limiting the irrigation season to 3.5 weeks decreased applied water depths further and had a more noticeable impact on grain yields for center pivot irrigation. On a Hord silt loam, the yield was reduced by 14% while on the Wood River soils the yields were reduced by 16% compared to the maximum yields. Applied water decreased by 39% with both Hord soil and Wood River soils. Also for both soils, net depletion was reduced by 33% and return flow by 60% compared to maximum yield conditions.

Results from furrow simulations with a limited 5 week season showed less than 1% yield reduction for both Hord and Wood River soils. Reduction in applied water was similar between furrow irrigation types and soils. An average reduction of 20% was observed. Net depletion was reduced an average of 5%. Return flow was reduced on average 36% for Hord soil for both tillage systems. On Wood River soils with conventional tillage, return flow was reduced by 65% and for ridge till it was reduced by 55%.

When furrow irrigations were limited to a 3.5 week season, large yield reductions occurred. For Wood River soils with conventional tillage and continuous flow irrigation, yields were reduced by 10%, and for surge flow they were reduced by 19%. With ridge tillage, yields were reduced by 8% for all irrigation types. The yield reductions were similar with Hord soils being 7% for the two types of tillage. The exception was continuous flow with runoff recovery using ridge till. Here the yield reduction was 14%. Net depletion for continuous flow with runoff recovery and ridge till on a Hord soil was reduced 37%. Net depletion for surge flow using conventional tillage on a Wood River was reduced 34%. Net depletion results for all other furrow simulations showed an average reduction of 20%. The higher reduction in net depletion for the two unique cases explain the greater yield reduction for these cases. Return flow was reduced an average of 60% for the Hord soils and 75% for the Wood River soils.

Dryland management resulted in a grain yield for corn (2750 GDD) of 4625 kg/ha for the Hord silt loam soil and 4200 kg/ha for the Wood River silt loam.

Cropping systems. The results for the four crops: corn (2750 GDD), corn (2600 GDD), grain sorghum, and soybeans, are shown in Figures 5-7. These results are for center pivot with impact sprinklers and furrow irrigation with surge flow using conventional tillage and the different irrigation seasons.

For the Hord soil, center pivot with impact sprinklers, and conventional tillage, the yield, water applied, and net depletion was reduced 5%, 6%, and 9%, respectively, for the 2600 GDD corn compared to the 2750 GDD corn when irrigating for maximum production. The maximum production grain sorghum and soybeans had net depletions of 36% and 16%, respectively, less than 2750 GDD corn.

Compared to irrigating for maximum yields, when the irrigation season was limited to 5 weeks, the yield and net depletion were reduced by 1% and 6% respectively, for grain sorghum. The 3.5 week irrigation season resulted in grain sorghum yield and net depletion reductions of 5% and 21%, respectively.

For soybeans, yield and net depletion were reduced by 1% and 3%, respectively, for the 5 week growing season and 8% and 25%, respectively, for the 3.5 week growing season compared to irrigating for maximum yield.

Dryland yields for the three additional crops was 4775 kg/ha for corn (2600 GDD), 4300 kg/ha for grain sorghum, and 2150 kg/ha for soybeans.

CONCLUSIONS

(Irrigating for maximum yield)

When irrigating for maximum grain yield for 2750 GDD corn, center pivot irrigation requires 28% less applied water than furrow irrigation for a Hord silt loam soil, but for a Wood River silt loam soil, applied water depths were similar between systems.

Net depletion is reduced when LEPA irrigation is used compared to impact sprinklers.

Return flow was 64% less when using a center pivot verses a furrow irrigation system with Hord silt loam soils while little difference was observed between irrigation systems with Wood River soils.

Surge flow when compared to continuous flow irrigation, reduced return flow by 40% for Hord soils and 25% with Wood River soils.

(Tillage comparison)

Ridge till reduced net depletion by 25% when compared to conventional tillage using furrow irrigation. The reduction was a result of increased effective rain and reduced soil water evaporation.

(Limited irrigation season - 5 week)

Limiting an irrigation season to 5 weeks resulted in only a 1-3% corn yield reduction while applied water was reduced by 20% for all soil, tillage, and irrigation combinations.

Net depletion for center pivots was reduced by 13% and for furrow irrigation, by 5% when the season was limited to 5 weeks.

Return flow was reduced 36 - 65% as a result of the limited irrigation season.

(Limited irrigation season - 3.5 weeks)

Larger yield reductions occurred when the irrigation season was limited to 3.5 weeks. Center pivot corn yields were reduced by 15% while furrow irrigation showed a reduction ranging from 7-19%.

Net depletion was reduced by 33% for center pivots and 25% for furrow irrigation.

Return flow was reduced by 60% with center pivots and 60% - 75% for furrow.

(Comparison of different crops)

Relatively small water savings were observed by switching to a shorter season corn (2600 GDD) or soybeans from a 2750 GDD corn.

Grain sorghum required 26% less applied water and had 30% less net depletion compared to other crops.

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Nutrient Patterns, Mainstem South Platte River, Denver to Julesburg, Colorado: Seasonal and Temporal Variations a Longterm Tom Sawyer Monitoring Program

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The nitrogen and phosphorus levels in the mainstem South Platte River have been monitored since December, 1993, through a cooperative effort of agencies performing laboratory water quality analyses and a network of schools collecting water samples. Twice monthly on the same day, teams of students collect samples at 16 mainstem South Platte sites from Denver to Julesburg, Colorado. Samples are returned to Denver and analyzed by three laboratories. Analyses of a conservative substance, sulfate, revealed that loadings and concentrations were lowest near Denver and highest at the Nebraska border. Maximum phosphorus concentrations were found downstream of Denver while maximum nitrate concentrations were found downstream of Greeley, Colorado. Maximum nitrogen and phosphorus loadings in the river were not found at the Nebraska border, but just downstream of Greeley, Colorado, where maximum flows were recorded. An extensive irrigation water diversion system resulted in much lower flows (and lower N and P loadings) in the portion of the river from Fort Morgan to Nebraska. A 95% denitrification of water stored in Jackson Reservoir reduced nitrate, and nitrogen loadings, in the mainstem river, while surfacing groundwater in the same reach decreased nitrate, and loadings, through both dilution and denitrification. Nitrite concentrations increased in the lowest 35 mile stream reach from the denitrification of surfacing groundwater as it entered surface flows. A complex system of water diversions, fertilization, denitrification, and discrete point sources such as domestic wastewater plants influence nutrient and aquatic communities in all flowing and standing waters of the basin.

Restoration of Two Platte River Basin Sandpit Lakes: Phosphorus Reduction using Aluminum Sulfate

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Degradation of water quality in Platte River basin sandpit lakes is a concern in Nebraska. Over 800 publicly and privately owned sandpit lakes exist in the State which are used extensively for recreation by a large group of people with diverse interests (i.e. swimming, boating, fishing, hunting, SCUBA-diving, etc.). Nutrient loading, particularly phosphorus, has accelerated eutrophication of many once pristine sandpits and thus greatly reduced their recreational value. Water quality problems to date include nuisance algal blooms, low water transparency, noxious odors, dissolved oxygen depletion, and fish kills. Sediment phosphorus release (internal loading) during the growing season appears to be the main input in sandpit systems and must be controlled to alleviate water quality problems. Phosphorus inactivants such as aluminum sulfate (alum) offer a non-toxic, potentially long-term method of reducing internal phosphorus loading. Alum addition results in a floc which forms a "blanket" over the sediments and can continue to absorb and retain phosphorus for years.

In the summer of 1994, following a two year pre-treatment monitoring program, alum was added to two sandpit lakes in the Platte River basin near Fremont, NE. Post-treatment monthly monitoring data show that epilimnetic total phosphorus was reduced from >100 MgL(- 1) to 40-50 MgL(-1). Summer hypolimnetic total phosphorus was reduced from 500-1000 MgL(- 1) to 50-100 MgL(-1) indicating that the alum is controlling sediment phosphorus release. Lower phosphorus concentrations also resulted in lower summer chlorophyll a concentrations and greater water clarity. In addition, alum treatment reduced the anoxic zone, thus increasing fish habitat. Initial results indicate that alum has the potential to be an effective, non-toxic sandpit lake management tool in Nebraska. Benefits include: reduced internal phosphorus loading, decreased water column phosphorus concentrations, greater water clarity, reduced algal biomass, and a decrease in the frequency and intensity of algal blooms. The longevity of phosphorus control (and associated benefits) will determine the cost effectiveness of alum treatments.

Chronic Effects of Baseflow Levels of Atrazine on Platte River Algae

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A single species bioassay was conducted on a common diatom from the Platte River to determine the chronic effects of low levels of atrazine, the most widely used herbicide in the state and in the U.S. Five clonal axenic cultures of *Craticula cuspidata* were established from attached algae collections from five sites along the central Platte River near Grand Island, and four clones of the same species were obtained from the Loras College Diatom Culture Collection (i.e. no prior exposure to atrazine). Cultures were maintained in WC-enriched medium in a growth chamber at 20 degrees Celsius on a 12:12 light-dark cycle. All cultures received a chronic 10-wk treatment of 1Mg/L atrazine and growth was monitored using a fluorometer. Cultures were transferred biweekly to prevent nutrient depletion and to maintain a more constant atrazine concentration. Following the chronic treatment, clones were exposed to six concentrations of atrazine (93, 187, 375, 750, 1500, and 3000 Mg/L). EC [50] values (i.e. concentrations eliciting a 50% reduction in growth) were determined after 7, 9, and 12 days to ascertain whether prior exposure influences the ability of this species to tolerate higher levels characteristic of spring pulses of the herbicide. Atrazine levels were monitored using GC/MS or GC.

Statistical analyses indicate that the chronic atrazine exposure effect was significant during the first day of treatment (P=0.0001); however no significant difference was detected throughout the remainder of the 10-wk treatment for either the Platte River or Loras clones. Thus it appears that long-term, low level exposure to atrazine does not affect the growth rates of these clones of *Craticula cuspidata*. Preliminary results from the acute treatments indicate that prior chronic exposure to atrazine has a negative effect on growth rates.

The Platte River Watershed Protection Program: The Middle Platte Companion Economic Assessment

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The Middle Platte Ecological Response Assessment is intended to provide information needed to identify relationships between ecosystem components and human activities. In order to develop appropriate management options, it is imperative that decision-makers have access to accurate integrated ecological and economic information. In the initial phase of the Companion Economic Assessment, researchers generate a baseline economic profile of the Middle Platte region to serve as a reference point in the evaluation of possible management strategies. Researchers identify the significant economic characteristics of the region, and package this information in an index format conducive to public discussion. To guide future policy analysis, researchers also identify shareholder goals and develop a regional sectoral economic model. In terms of the local ecology, the allocation of water is the critical resource issue. The availability of water has a significant impact on land values, agricultural output, recreational opportunities, and other regional economic activities. The baseline profile provides the information necessary to identify the current commercial uses of water and the eventual development of an input/output model to determine the local economic impacts resulting from a change in the price or quantity of water.

Wintering Bald Eagle Survey of the Central Nebraska Public Power and Irrigation District Supply Canal from the Tri-County Diversion Dam to the J-2 River Return, 1992-1995

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Since 1992 the Central Nebraska Public Power and Irrigation District (Central) has monitored bald eagle use of its system from the Tri-County Diversion Dam at North Platte, Nebraska, to the Platte River just below the J-2 River Return near Lexington, Nebraska. This portion of Central's system was identified in previous studies as having one of the highest concentrations of wintering bald eagles in State.

In 1994-1995 we conducted twelve surveys beginning in early December, lasting through February. Each survey consisted of observations at 16 locations along the supply canal, canyon lakes of the system, and the Platte River. Data gathered in 1994-1995 was then compared to observations from 1992-1993 and 1993-1994.

Five hundred and sixty-nine bald eagle sightings were recorded from the 16 locations. The three locations with the highest counts were Johnson Lake (131), the J-2 tailrace (90), and the Jeffrey River Return (53).

This is a reduction in the number of eagles counted in 1993-1994, but an increase over those counted in 1992-1993. This yearly fluctuation in eagles utilizing project waters follows the same patterns of fluctuations seen in the numbers of bald eagles census on the Platte River as a whole and throughout the entire state.

WINTERING BALD EAGLE SURVEY OF THE CENTRAL NEBRASKA PUBLIC POWER AND IRRIGATION DISTRICT SUPPLY CANAL FROM THE TRI-COUNTY DIVERSION DAM TO THE J-2 RIVER RETURN, 1992-1995

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INTRODUCTION

The Central Nebraska Public Poer and Irrigation District (Central) and Nebraska Public Power District conducted monitoring studies from 1987 to 1991 to evaluate the use by wintering bald eagles of the canal and lake systems associated with FERC Projects 1417 and 1835. The results of these studies were reported in 1990, 1991, and 1993 (Plettner, 1993; Stalmaster and Plettner, 1991; Stalmaster, 1990; and Plettner, 1990)

Central has continued to monitor bald eagles along Central's canal and lake system since 1992. The survey originally consisted of obsevations made at ten locations between Gallagher Canyon and the Platte River just below the J-2 Return. The 1987-91 studies identified this stretch of the Supply Canal and associated lakes as having the highest numbers of wintering bald eagles. The results of the first two years of the survey were reported in 1993 and 1994 (Schmid, 1993 and Peyton, 1994). The survey was expanded in 1994-95 to include six additional sites extending west of Gallagher Canyon to the beginning of the Supply Canal located at the confluence of the North and South Platte Rivers. The results of the 1994-95 survey arer presented here.

STUDY AREA

The Central District's Supply Canal is 120 km long. It begins near North Platte, Nebraska, at Central's Diversion Dam, which is located on the Platte River approximately one-half mile below the confluence of the North and South Platte Rivers, and ends at the J-2 River Return near Lexington, Nebraska. Twenty-six small reservoirs, ranging in size from less than an acre to 2,500 acres, and three hydroelectric plants are located along the canal.

Ten locations were surveyed in 1992-93 and 1993-94. From east to west they are: the Platte River form the Bertrand Road to the J-2 River Return; the Canaday Steam Plant; bridge 73.4; bridge 72.4; the J-2 Hydroplant; East Phillips Lake; the J-1 Hydroplant; Johnson Lake; Plum Creek Lake; and Gallagher Canyon Lake.

The six additional sites added in 1994-95 are: the Platte River bridge south of Overton; Midway Lake; Hiles Canyon Lake; the headgates of the 30-Mile Canal; Jeffrey Hydroplant; and the Central District Diverison Dam.

METHODS

A total of 12 bald eagle surveys were conducted weekly from 9 December 1994 to 22 February 1995. Surveys began at 8 a.m., CDT and were concluded by 3 p.m. The observer drove to the designated observation points and counted the birds visible from that point, noting any special conditions. Birds were identified as adult, juveniles or unknown if age could not be determined.

RESULTS

A total of 560 bald eagle sightings were made from the 16 selected locations. Eagles were seen on each of the 12 days of the survey and at least once from every location except Hiles Canyon Lake.

The highest counts during the survey were gathered at Johnson Lake, the J-2 Hydroplant, and the 30-Mile Canal headgates, where the totals for the survey period were 131, 90, and 53 eagles respectively.

The highest single count was 97 bald eagles on 8 February, with a low of eight on 9 December. The average was 47 bald eagles per day. Immature eagles comprised 21.6% of all bald eagles counted with a high of 26 on 15 February and a daily average of ten. The percentage of immature eagles counted per survey ranged from 10% in mid-December to 34% in late February.

From the original ten locations between the Platte River below the J-2 River Retrun and Gallagher Canyon, 430 eagles were counted in 1994-95 for an average of 35.8 eagles per day. This is slightly higher than the 33.2 eagles per day average seen at these locations in 1992-93 and much lower than the average of 57.1 eagles perday in 1993-94.

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Alternative Uses for Marginal Cropland in the Platte Valley

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In 1994, The Nature Conservancy acquired a tract of land adjacent to the Platte River south of Alda as the Studnicka farm. Land use on the farm consisted of 114 acres of fields usually planted to corn and/or soybeans, a 22 acre pasture planted to tall wheatgrass (*Agropyron elongatum*), and a 20 acre native haymeadow. Due to a high water table and some soil salinity problems, crop production on the site has been erratic with the tenant farmer only realizing a profit about three out of every five years. The Conservancy, in conjunction with UNL scientists and the tenant, began looking at methods to improve the site, both from the standpoint of wildlife habitat and to make it more consistently profitable for the tenant farmer.

Initial improvements included converting some of the least productive land on the site to a wetland and planting a high diversity (100 species of native, locally collected grass and forb seed) filter strip between the river and the crop fields. After a very poor year for crop production in 1995, it was decided to plant the most productive part of the site to alfalfa and convert the rest to perennial grass cover, including areas to be planted to eastern gamagrass (*Tripsacum dactyloides*), a warm season native grass. Eastern gamagrass is an exciting potential forage crop for the Platte valley. It is highly productive, highly nutritious for livestock, and is well adapted lowland areas that are subject to a high water table or occasion flooding and are consequently difficult to farm. Properly managed eastern gamagrass pastures are capable of producing net revenues comparable to what is currently being produced on the site with convential row crops and without the associated risk.

Planting perennial forage grasses, and eastern gamagrass in particular, on marginally productive land in the Platte valley may offer long-term economic advantages over row crops as well ecological benefits.

Impact of Selected Herbicides and Metabolites in the Platte and Elkhorn Rivers on Collector Well Water, Nebraska

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The effect of surface water contamination in the Platte and Elkhorn Rivers on water supplied to Lincoln, Nebraska, by two collector wells located on an island 5 miles downstream of the confluence of these rivers was evaluated. Spatial and temporal variations in concentrations of selected herbicides and metabolities in the two rivers were examined in 1994 and 1995 using samples collected five times (before spring herbicide applications (twice), during a spring-runoff event, in July, and in September) at four locations. During the 1995 spring- runoff event, samples also were taken from both wells and the Platte river about 0.5 miles upstream of the island.

The largest concentrations of herbicides and metabolities occurred in both surface water and the municipal water supply during the spring-runoff event, with atrazine concentrations in the wells about one fourth of those in the Platte River. The largest concentrations in the well water during the spring-runoff event were 2.05 Mg/L atrazine, 0.28 Mg/L deethylatrazine, 0.31 Mg/L deisopropylatrazine, 0.23 Mg/L alachlor, 1.16 Mg/L ethanesulfonic acid derivative of alachlor, 0.63 Mg/L metolachlor, 2.22 Mg/L cyanazine, 0.69 Mg/L cyanazine amid, and 0.36 Mg/L acetochlor. In surface water, atrazine, deethylatrazine, and ethanesulfonic acid derivative of alachlor were present during all sampling events. Other herbicides and metabolites also were detected in surface water, especially during the spring-runoff event. The amount of mixing of both rivers prior to reaching the wells' location appears to depend upon the flow conditions of both rivers. Several days' time lag exists between the time the Platte River water quality changes and the time when related changes appear in the water quality of the wells.

Landscape Ecology: A Primer and Overview of Application to the Central Platte River, Nebraska

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Paul Currier, Platte River Whooping Crane Maintenance Trust, Inc., Grand Island, Nebraska

A landscape is a heterogeneous area composed of a mosaic of local, interacting ecosystems or "habitat patches", which are distributed in a "matrix" differing in composition. In the central Platte River landscape, this mosaic includes the river and associated wetlands, croplands, pastures, riparian zones, native grasslands and urban areas. Such spatial mosaics and particularly the effect of their spatial configurations on ecological processes and patterns are of principle interest in the rapidly emerging discipline of landscape ecology. In this presentation we outline some basic principles of landscape ecology. We then discuss their application to our ongoing investigations of the landscape ecology of the Platte River region.

Use of GPS/GIS for Accuracy Assessment of Remotely Sensed Imagery

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Satellite imagery forms the basis of many studies of the Platte River. However, land classifications based on the imagery are, ideally, subject to verification. We present the results of one of the first point-to-point accuracy assessments of a land cover classification using a global positioning system (GPS) and geographical information system (GIS). We classified TM satellite imagery into seven major land cover classes for the area: water, forest, agriculture, wet meadow, grassland, urban, and bare areas. At least 30 random polygons were selected in each class and then visited in the field where a ground control network was taken at each location. A 3x3 pixel grid based on these ground control networks was then constructed in a GIS to overlay the ground truth data on the classified image. From this, accuracy on a point to point basis was made to evaluate the classification accuracy of the image.

Factors Influencing Red-eyed Vireo Habitat Selection in Forest Fragments Along the Central Platte River, Nebraska

Christopher J. Colt and Dennis E. Jelinski, University of Nebraska-Lincoln, Department of Forestry, Fisheries, and Wildlife, Lincoln, Nebraska

Habitat patch size has been shown to be an important variable in habitat selection by a great many species. We hypothesize that while patch size may be important, the nature of adjacent land-use may confound analysis of the effect of patch size. We present the results of an investigation examining the occurrence of breeding red-eye vireo (*Vireo olivaceus*) in relationship to forest patch size in riparian woodlands of the central Platte River, Nebraska, when the proximity to roads is considered in conjunction with area/species relationship.

The Effect of Landscape Fragmentation on the Distribution of Wet Meadow Grassland Birds

Chris Helzer and Dennis E. Jelinski, University of Nebraska-Lincoln, Department of Forestry, Fisheries, and Wildlife, Lincoln, Nebraska

This study investigates the effects of a spatially heterogeneous landscape on grassland breeding birds in wet meadows in central Nebraska. Forty four wet meadow patches were censused for birds twice during the 1995 breeding season. Additionally, vegetation and landscape variables were collected. Preliminary analysis of this 1995 data shows that perimeter- area ratio, patch size, and adjacent patch type are strongly correlated with core species richness and species presence for core species. The incidence of core grassland birds increased dramatically with increasing patch size and decreasing perimeter-area ratio. Most non-grassland birds, conversely, showed much smaller or no trends with those variables. The extent of trees and roads (as opposed to cropland) surrounding patches was negatively correlated with species richness and the percent occurrence of individual species. Vegetation structure variables also appeared to be important predictors, though less so than patch and landscape variables.